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Original Research Article

Enhancing Productivity and Quality of Soybean through Mulching and Anti-Transpirants in Jharkhand, India

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A B S T R A C T

A field experiment was conducted for three consecutive years during *kharif* season of 2012, 2013 and 2014 to assess the effect of mulch and anti-transpirants on growth, yield and quality of soybean. Result indicated that application of mulch @ 5 tons ha^{-1} significantly increased plant dry weight, yield attributes, grain yield, straw yield, harvest index and quality of soybean. The highest grain yield (1705 kg ha^{-1}) straw yield (2274 kg ha^{-1}) and harvest index (42.84 %) was recorded with application of mulch @ 5 t /ha which was significantly superior to no mulch. Similarly maximum protein content (40.60%) oil content (19.81%) and oil yield (337.75 kg ha^{-1}) was recorded with application of mulch @ 5 t ha^{-1}. Significant variations in yield and harvest index was observed with different anti-transpirant applications and maximum grain yield (1755 kg ha^{-1}) straw yield (2342 kg ha^{-1}), harvest index (42.80%), protein content (40.60%) and oil content (19.81%) was recorded with application of KNO_3 @ 1%, which was significantly superior to all the anti-transpirants except Glycerol @ 5%. Its application registered maximum gross return (41676 ` $ha^{-1}$) net returns (15447 ` ha^{-1}) and B: C ratio (0.70) which was significantly better than all the anti-transpirants.

Keywords

Soybean, Mulch, Anti-transpirant, Grain yield and Quality

Introduction

Soybean (*Glycine max* (L.) Merril) has a prominent place among modern agricultural commodities, as the world's most important seed legume, which contributes about 25% to the global edible oil production, cultivated in an estimated global area of 121.53 million ha with a production reaching 314.81 million tones and productivity of 2.59 tones/ ha.

Among the major soybean growing countries, India ranks fourth in terms of area (11.6 m ha) under soybean and fifth in terms of production (7.1 m tons). In Jharkhand, the estimated area under soybean production is 10000 ha with total production of 6000 metric tons (Anonymous, 2016).

Moisture stress due to prolonged dry spells or thermal stress due to heat wave conditions significantly affect the agricultural productivity when they occur in critical life stages of the crop. There was a significant decrease in soybean yield as high as 96 % when the rainfall receded during the initiation of flowering to maximum pod stage. The yield reduction was 56% when a drought spell of around 2 weeks occurs during mid-vegetative stage. (Mohantey *et al.*, 2015).

Beneficial effects of mulching on moisture conservation, weed control, soil physico-chemical and biological conditions are reported (Mishra *et al.,* 2000). To obtain high yields there is a need to improve plant stand of soybean through higher emergence. Straw mulch lowers the maximum soil temperature, raises the minimum soil temperature in the seed zone and keeps the soil moist resulting enhanced seedling emergence (Singh and Jolly, 2008). Mulch application significantly increased the yield due to decrease in the evaporation and availability of adequate soil moisture for longer period (Ondal *et al.,* 2008) under limited water supply through the conservation of moisture and regulation of soil temperature. Erratic rainfall and early cessation of monsoon also affect the yield of soybean. Proper moisture at flowering stage is very critical for soybean production. At the time of flowering under moisture stress condition certain chemicals effectively reduces the water loss and improve the yield. Anti-transpirants regulates stomatal movement by influencing the guard cells around the stomatal pores and reduces loss of water but not intake of CO_2.The most efficient and desirable anti-transpirants are those which closes stomata while transpiration but produce no phyto toxic effects to plants (Gale and Hagan, 1966). Considering the beneficial effect of mulching and very meager information in regard to the effect of anti-transpirants on yield and quality of soybean in Jharkhand the present investigation was undertaken to study the effect of mulch and anti-transpirants on yield and quality of soybean.

Materials and Methods

A field experiment was carried out during *kharif* season of 2012, 2013 and 2014 in the Agricultural Research farm, Birsa Agricultural University, Ranchi, situated at an altitude of 625 m above MSL, 23º17"North latitude and 35 º 19"East longitudes entitled "enhancing productivity and quality of soybean through mulching and anti-transpirants in Jharkhand". The soil of the experimental field was sandy loam, acidic in reaction (pH 5.8), low in organic carbon (3.7g kg^{-1}), available nitrogen (213.24 kg N ha^{-1}), phosphorus (14.54 kg P_2O_5 ha^{-1}), medium in available potassium (180 kg K_2O ha^{-1}). The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of two mulches treatments viz., No mulch and straw mulch @ 5 tons/ ha after sowing and four anti-transpirants viz., Magnesium carbonate ($MgCO_3$) 5%, Glycerol 5%, Sodium carbonate (Na_2CO_3) 5% and potassium nitrate (KNO_3) 1%, with a control (water spray) comprising twelve treatment combinations. Soybean variety RKS 18 was grown at a row spacing of 45 cm. Crop received recommended basal dose of nutrients @ 20:80:40:: kg $N:P_2O_5:K_2O$ ha^{-1} through di-ammonium phosphate and muriate of potash, respectively. Soybean seed were inoculated with *Bradyrhizobium japonicum* culture @ 5 g kg^{-1} seed. Straw mulch @ 5 tons ha^{-1} was applied to the plots just after sowing and spraying of anti transpirants was done 15 days after flowering. Crop was harvested at physiological maturity, threshed and plot-wise seed and straw yields in kg/ ha was recorded. Final seed samples were taken from each plot for analysis of nitrogen by modified kjeldhal method as described by Black (1965). Protein content (%) was estimated by multiplying nitrogen content in grain with the factor 5.71(Sadasivam and Manickam, 1996). Oil content was estimated by Soxhlet extraction method. The biometric observations were taken from the 5 randomly selected plants of each plot demarcated with proper pegging. The plant dry weight destructive sampling procedure

was followed and three plants were uprooted from the 2nd row at either side of the plots. Crop growth rate (CGR) was calculated by adopting the following formulae as suggested by Watson (1952).

$$\text{CGR (g day}^{-1}\text{ plant}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where,

W_1 = Dry weight of plant (g) at time t_1
W_2 = Dry weight of plant (g) at time t_2
$t_2 - t_1$ = Time interval in days
A = Unit area occupied by plants (m^2)

Since data followed the homogeneity test, pooling of data was done over the seasons and mean data was statistically analyzed as per standard method prescribed by Cochran and Cox, 1957

Results and Discussion

Effect on plant dry matter and CGR

Dry matter production of soybean increased continuously up to maturity (Table 1) and application of mulch @ 5 t ha^{-1} recorded maximum dry weight (2.58, 9.13 and 18.41 g plant $^{-1}$) at 30,45 and 60 day after sowing (DAS) which was significantly superior to no mulch at all the stages of observation. Among anti-trasnspirants application of potassium nitrate (KNO_3) @ 1% registered maximum dry weight which was significantly better to sodium carbonate (Na_2CO_3) @ 2% and water spry (control). The CGR during 30 to 45 DAS and 45 to 60 DAS of crop were significantly influenced by mulching. Application of mulch @ 5 t ha^{-1} recorded significantly higher CGR no mulch at all crop growth stages. The CGR did not vary statistically due to application of anti-trasnspirants at all intervals of crop growth. Higher plant dry weight and greater CGR of soybean with mulching might be due to availability of moisture for longer period for better crop growth and supply of plant nutrients in adequate quantities. Similar results have been reported by (Sharma *et al.,* 2009).

Effect on yield attributes and yield

Yield attributes like number of pods per plant and 100 seed weight and grain and straw yield showed significant variations for mulching and anti-traspirants (Table 2). Maximum pod per plant and 100 seed weight were recorded with application of mulch @ 5 t ha^{-1} which was significantly better than no mulch. Similarly maximum grain yield (1705 kg/ha) straw yield (2274 kg/ha) and harvest index (42.84 %) was recorded with application of mulch @ 5 t ha^{-1} which was significantly superior to no mulch. Kumar *et al.,* (2015) summarized that use of bio- fertilizer along with mulching proved useful in increasing growth and yield attributes of potato as compared to control. Significant variations in yield and harvest index were observed with different anti-transpirant applications and maximum grain yield (1755 kg ha^{-1}) straw yield (2342 kg ha^{-1} and harvest index (42.80%) was recorded with application of KNO_3 @ 1%, which was significantly superior to all the anti-transpirants except Glycerol @ 5%. These findings are in conformity with Dalvi *et al.,* (1991) who reported significant differences on seed yield and harvest index due to anti-transpirants.

Effect on quality

Protein content, oil content and oil yield of soybean was significantly influenced by mulching and maximum protein content (40.60%) oil content (19.81%) and oil yield (337.75 kg ha^{-1}) was recorded with application of mulch @ 5 t ha^{-1} which was significantly superior to no mulch.

Table.1 Effect of mulching and anti-transpirents on branches, dry weight and CGR of soybean

Treatment	Dry weight (g /plant)			Crop growth rate (g /day/plant)	
	30 DAS	45 DAS	60 DAS	30-45 DAS	45-60 DAS
Mulching					
Without mulch	2.46	8.66	17.15	0.413	0.566
Mulch @ 5 t/ha	2.58	9.13	18.41	0.437	0.618
SEm±	0.02	0.07	0.14	0.004	0.007
CD (P=0.05)	0.06	0.21	0.40	0.012	0.021
Anti-transpirants					
$MgCo_3$ @ 5%	2.52	8.85	17.50	0.422	0.576
Glycerol @ 5%	2.57	8.98	18.05	0.427	0.605
Na_2CO_3 @ 2%	2.47	8.77	17.48	0.420	0.581
KNO_3 @ 1%	2.58	9.05	18.64	0.431	0.639
Water spray	2.47	8.83	17.22	0.424	0.559
SEm±	0.03	0.11	0.22	0.007	0.111
CD (P=0.05)	0.09	0.34	0.64	NS	NS

Table.2 Effect of mulching and anti-transpirents on yield attributes and yield of soybean

Treatment	Pods Plant^{-1} (no.)	100 Seed wt. (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Mulching					
Without mulch	36.99	9.72	1564	2148	42.10
Mulch @ 5 t/ha	44.16	10.15	1705	2274	42.84
SEm ±	0.44	0.11	16.15	22.37	0.24
CD (P=0.05)	1.31	0.31	47.99	66.47	0.71
Anti-transpirants					
$MgCo_3$ @ 5%	38.39	9.78	1616	2172	42.61
Glycerol @ 5%	41.58	10.15	1686	2282	42.44
Na_2CO_3 @ 2%	41.50	9.95	1603	2156	42.60
KNO_3 @ 1%	44.39	10.48	1755	2342	42.80
Water spray	37.00	9.31	1514	2102	41.90
SEm ±	0.70	0.17	25.54	35	0.38
CD (P=0.05)	2.07	0.50	75.88	105	NS

Table.3 Effect of mulching and anti-transparent on quality and economics of soybean

Treatment	Protein content (%)	Oil content (%)	Oil Yield (kg/ha)	Gross returns (`/ha)	Net returns (`/ha)	B:C ratio
Mulching						
Without mulch	38.58	18.82	294.44	38210	16368	0.94
Mulch @ 5 t/ha	40.60	19.81	337.75	41676	15447	0.70
SEm ±	0.16	0.08	3.16	403	361	0.03
CD (P=0.05)	0.48	0.24	9.40	1198	1073	0.08
Anti-transpirants						
$MgCo_3$ @ 5%	39.49	19.26	311.83	39469	8339	0.29
Glycerol @ 5%	39.67	19.35	326.53	41217	15951	0.70
Na_2CO_3 @ 2%	39.66	19.35	310.75	39059	13773	0.61
KNO_3 @ 1%	39.78	19.41	340.78	42963	21906	1.20
Water spray	39.36	19.20	290.59	37006	19569	1.32
SEm ±	0.26	0.13	5.00	637	571	0.04
CD (P=0.05)	NS	NS	14.87	1894	1696	0.12

Application of anti-trasnspirants fails to make any significant variation in protein content and oil content. However, oil yield was significantly influenced by anti-tranpirants and application of potassium nitrate (KNO_3) @ 1% registered maximum oil yield (340.78 kg ha^{-1}) which was significantly better to all the anti-tranpirants except Glycerol @ 5%.

Effect on economics

Application of mulch significantly influenced the economics of soybean production (Table 3) and maximum gross returns (41676 ` $ha^{-1}$) net returns (15447 ` ha^{-1}) and B: C ratio (0.70) was recorded with application of mulch @ 5 t ha^{-1} which was significantly better than no mulch treatment. Among anti-transpirants application of potassium nitrate (KNO_3) @ 1% registered maximum gross return (41676 ` $ha^{-1}$) net returns (15447 ` ha^{-1}) and B: C ratio (0.70) which was significantly better than all the anti-transpirants.

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